GRIZZLY BEAR RESPONSE TO FOREST ROAD DENSITIES AND TIMBER MANAGEMENT IN A MULTIPLE USE ENVIRONMENT

RESEARCH UPDATE[1]

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS[2]

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INTRODUCTION

This report details results of data collected by the Montana Department of Fish, Wildlife and Parks' South Fork Flathead Grizzly Bear Project (SFGP) on grizzly bears living in habitat administered under a multiple-use management strategy. Information contained in this Update was prepared at the request of Flathead National Forest for a Biologist meeting dated 10 December, 1992. Specifically, this Update provides managers with current research information from the Northern Continental Divide Ecosystem (NCDE) regarding the observed relationships among grizzly bears, road densities, and timber management practices. The data analyses and interpretations should be considered preliminary. We have not made extensive comparisons of our findings to those of comparable studies reported in the literature.

The use of specific habitats by any wildlife species can be described at different levels of detail: from a broad perspective to use of smaller habitats. It is not our intent to describe the detailed habitat selection patterns of grizzly bears. Rather, we will evaluate grizzly bear habitat selection using broad categories (e.g. roaded versus unroaded, treated versus untreated). We specifically contrast habitat use in low and high elevation areas.

It is extremely important to note that our procedure for mapping and describing road densities differs in several significant ways from that used by the federal agencies in the NCDE or the Cabinet-Yaak Ecosystem. Land management agencies currently describe and evaluate grizzly bear habitat in terms of an **average**

open road density over a large block of habitat termed a Bear Management Area (BMA). An inherent assumption is that human use of administratively closed roads has a negligible affect on grizzly bear use of habitat. Within BMAs there exist areas with no roads, closed roads, low road densities, and relatively high road densities. However, the procedure currently used can not evaluate the relationship between road densities and grizzly bear use of habitats within various road densities. Furthermore, an average road density does not allow for specific project level planning within a BMA or an adequate means to evaluate the suitablity of adjacent security areas. For example, a BMA may have an average open road density of 1 mile of road/mi^2. However, 50% of that BMA may be unroaded (0 road density) and the other half might have a density of 2 miles of road/mi^2. How do grizzly bears partition their use within such a BMA? Are 50% of their locations in the roaded portion, or none at all? We will address this question.

ANALYSIS AREA

The 268-mi^2 analysis area was located within the Flathead National Forest in the Swan Mountain Range in western Montana. The analysis area extended from the Pioneer Ridge/Jewel Basin area on the north to the Bob Marshall Wilderness boundary on the south. The western boundary of the of the area was the Swan Mountain Divide, and the eastern edge was Hungry Horse Reservoir (Fig. 1).

METHODS

Grizzly Bear Location Data

Telemetry data were collected between autumn 1987 and autumn

1992 from 31 grizzly bears. Bears were captured, marked, and instrumented using methods described by Mace et al. (In press). Specific locations were obtained from fixed-wing aircraft one time per week from 1987-1990 and 2 times per week from 1991-92. Our best aerial locations were referenced to map coordinates and entered into the computer as a map of grizzly bear point locations.

Mapping Process

The relationships between grizzly bears and multiple-use habitat were investigated using several computer-generated maps in a Geographical Information System (GIS) software system (Manley and Mace In press). It was then possible to overlay and analyze grizzly bear telemetry locations in relationship to these maps alone and in combination. Descriptions of these maps are given in Table 1. We defined our habitat terms as follows:

1) low elevation habitats: all habitats between the elevation of 3281 and 5249 ft.

2) high elevation habitats: all habitats >5249 ft.

3) silviculturally treated habitats: areas with a history of timber management activity

4) untreated habitats: areas that have no known history of timber management activity

Our analyses of road density do not use the averaging routine previously described. We used a GIS modeling routine to more precisely map road densities within the entire analysis area (Manley and Mace 1992). We converted our map of linear roads to a map of road densities (miles of roads/mi^2). The entire analysis area was divided into 770,133 cells (pixels), each 30 m x 30 m in size. Each cell was then classified as having a precise road

density. For example, a 30 x 30 m cell with 2 miles of roads within a 1-mile square was assigned a road density of 2 mi/mi^2. Cells with no roads within a 1-mile square were classified as unroaded. Using this procedure for the entire analysis area, we classified each cell as belonging to one of 4 road density classes varying from 0 miles of road/mi^2 to 2+ miles of roads/mi^2. We built 2 road density maps. A total road density map was built using all but revegetated roads. We defined a revegetated road as a road where vegetation succession had progressed to the point where motorized vehicle or unincumbered foot travel was deterred. The open road density map used only permanently open and seasonally open roads.

Analysis Process

The grizzly bear location file was divided into 4 classes representing different grizzly bear age and sex classes. We developed a location file for adult males (n=246), adult females (n=937), subadult males (n=180), and subadult females (n=334).

Grizzly bear selection for (or against) specific habitats and road densities was analyzed using the concept of habitat availability and use (Neu et al. 1974). We determined the percentage of each habitat feature (as described in Table 1) present in the analysis area. This constituted "habitat availability." By overlaying telemetry locations on each map, the proportion of use (P) for each age and sex class was determined. Significant deviations from availability were used to describe the level of grizzly bear selection for each habitat. Habitat

selection was classified into 3 groups based on 95% simultaneous confidence intervals (Byers et al. 1984). These levels of selection were:

- : habitats used significantly less than available
= : habitats used by bears in proportion to the amount of that habitat in the analysis area,
+ : habitats used in a significantly greater proportion than available in the analysis area.

RESULTS

Relationship of Grizzly Bears to Elevation:

Grizzly bears used both low and high elevation habitats. Adult females were more selective than other age/sex classes, using high elevation habitats greater than expected and low elevation habitats less than expected (Table 2). Other age/sex classes used both elevation classes in proportion to availability.

Relationship of Grizzly Bears to Treated Habitats:

Sixteen percent of the entire analysis area was silviculturally treated and 84% was untreated. Eighty-three percent of the treated stands were at low elevation. Thirty-one percent of the low elevation area had a history of treatment. Ten percent of 1697 grizzly bear locations occurred in treated stands.

Adult females used high elevation untreated habitats greater than expected (Table 3). Both adult and subadult females used low elevation treated stands less than available. Males used treated and untreated stands at both elevations as available.

When grizzly bears used treated stands, they did not appear to "prefer" a specific silvicultural prescription. Removal methods (e.g. clear-cutting, shelterwood) were used as available (Fig. 2).

Age of harvest was important to grizzly bears. Treated stands < 12 years old were used significantly less then expected by bears relative to older treated stands.

Relationship Between Grizzly Bears and Low Elevation Treated, Forested, and Open Habitats:

We classified low-elevation habitat into 3 broad categories: 1) areas that have been silviculturally treated, 2) closed-canopy coniferous forest, and 3) all other habitats (generally natural openings in the overstory). Treated, forested, and other habitats represented 31, 43, and 26% of the total low-elevation area respectively.

While at low elevation, all age/sex classes used untreated open habitats greater than available (Table 4). Females used low elevation treated habitats less than available. Males used untreated forested stands less than available and treated stands as available.

Relationships Between Grizzly Bears and Roaded or Unroaded Habitats:

We classified habitats within the analysis area as either roaded (< 0.5 miles from any road) or unroaded (> 0.5 miles from any road). Forty-two percent of the analysis area was unroaded and 58% was roaded. Sixty-five percent of the roaded area was at low elevations.

Females used high elevation unroaded habitat greater than available (Table 5). Adult females used low elevation roaded habitats less than available. Males used low and high elevation habitats as available, whether roaded or not.

Relationships Between Grizzly Bears and Precise Road Densities:

Total Road Densities:

Female grizzly bears used zero total road density habitats greater than expected while males used these unroaded habitats as available (Table 6). Generally, grizzly bears used habitats having a total road density of 0.1 to 2.0 mi/mi^2 as available. Twenty-two percent (59 mi^2) of the analysis area had a precise total road density of >2.0 mi/mi^2. These areas were used less than available by all age/sex classes.

Open Road Densities

Preference, as exhibited by use-availability statistics, indicated a shift in use of an area when precise open road densities approached 1.0 mi/mi^2. Adult bears used areas with >1.0 mi/mi^2 less than available. Adult females used areas with an open road density of 0 mi/mi^2 greater than expected.

DISCUSSION

Techniques for Calculating Road Densities:

Techniques for calculating road densities that average over large blocks of land (e.g. a BMA), inclusive of both high and low elevations, result in inadequate assessments of grizzly bear response to road densities. Grizzly bears adjust their habitat use patterns in part to both precise open road densities and precise total road densities. Unless a road has completely revegetated, managers should assume some level of human use is occurring along closed roads and grizzly bears will respond to that use. Using an average road density figure, derived from a large area, will not

detail the precise road densities within smaller areas. This average density figure will not accurately predict bear use within those small areas.

The current method employed by land managers to calculate road densities, using an average open road density only, has a tremendous effect on how road density standards are interpreted and applied to grizzly bear habitat. For example, our entire analysis area has an average open road density of 0.63 mi/mi^2 and meets current road density standards. Our precise open road density technique produces the same average open road density. However, from our method we know that 26% of the analysis area (70 mi^2 of habitat) exceeds the 1.0 mi/mi^2 standard. When all roads are included in calculations for our analysis area, the average total road density is 1.13 mi/mi^2 with 22% (58 mi^2) of the area having >2 mi/mi^2. This 58 mi^2 of habitat was used less than expected by radio-instrumented grizzly bears.

When only open roads are used in density calculations, the influence of closed roads is removed. For example, an area may have an open road density of 1.0 mi/mi^2; thus there is 1 mile of open road for each square mile of habitat. However, this same area could also have 2 miles of closed roads per square mile, an actual total road density of 3 mi/mi^2. This area would still meet the 1mi/mi^2 open road density standards, but according to our data areas where the total road density exceeded 2mi/mi^2 would recieve use less than expected.

Grizzly Bear Use of Elevation Zones:

Grizzly bears require habitats found at both low and high elevations and move between these zones during each season and for variable periods of time. Adult females were especially tied to high elevation habitats. Because grizzly bears can not be restricted to high elevations only, we believe land management alternatives should be evaluated and displayed relative to both low and high elevation "impacts."

Road Densities and Grizzly Bears:

Our data suggest once a decision is made to road and silviculturally treat stands in a previously unroaded area, that area will subsequently be used less by female grizzly bears. This response by female bears is predicted to occur regardless of what silvicultureal treatment is chosen. Once precise total road densities reach 2 mi/mi^2, use by all bears is predicted to significantly decline. Closing roads has a positive effect on use of an area by grizzly bears when precise open road densities are reduced below 1.0 mi/mi^2.

The amount of area with a total road density of >2 mi/mi^2 in our analysis area is considerable. Juxtaposition of this 59 mi^2 to other lands with other classes of road densities and associated covertypes is critical for determining the overall quality of the habitat.

Timber Harvest and Grizzly Bears:

Our data imply that human use of the low elevation roaded environment negates bear use of treated stands. The management concept of "habitat improvement" through silvicultural treatment

may only apply where grizzly bear security is maximized. Ten percent (n=169) of 1697 telemetry locations from 31 individual grizzly bears over 5 years occurrd in silviculturally treated stands. No age/sex class selected specifically for treated stands. While at low elevations, grizzly bears in the analysis area used treated stands less than available.

Although not detailed here, Waller (1992) determined that individual grizzly bears varied considerably in their use of treated stands. From our data we know that several treated stands in the analysis area were very important to bears while foraging on huckleberries. However, the vast majority of treated stands in the analysis area were never used by bears.

Effects on Population:

Grizzly bears can live and reproduce in multiple-use habitats within the NCDE. The data strongly suggest that grizzly bears are not able to fully exploit habitats, especially low elevation ones, because of human activity. The ultimate question, then, becomes one of desired population size and long-term trend. For a population to grow, adequate habitat must exist to accommodate young bears upon dispersal. Adult females in our study generally used the most secure habitats; use of such habitats is how an individual gets to be an older bear. If these habitats are reduced in quantity, we predict that the total number of females will eventually decline. If the goal is to increase bear numbers in a given area, then adequate secure habitat must be maintained for all segments of the population, including subadult animals.

LITERATURE CITED

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Table 1. GIS map layers used to investigate habitat use of grizzly bears living in a multiple-use environment.

Map Name	Description
Griz1	1697 telemetry locations from 31 grizzly bears from 1987 to 1992.
Treated	a map of the core area only showing each treated (harvested) stand, removal method, and age of stand. This map has only 2 habitats: treated or untreated. Obtained from USDA Forest Service.
Elevation	The study area was divided into 2 elevation zones. High elevation included all areas > 5249 ft. Low elevations were those areas <5249 ft.
Lowtype	this map was built to evaluate 3 habitats at low elevation only. The entire core <5249 ft. was classified as either treated, close canopy forest, or other. Generally, "other" refers to low elevation natural openings.
Total road density	this map was created using methods of Manley and Mace 1992. It displays exact road densities at a 30m resolution. We included all roads in this map, not just open roads. The entire analysis area was classified into 4 road density classes ranging from 0 mi/mi^2 to 2+ mi/mi^2.
Open Road density	This map used only perminantly open or seasonally open roads within the analysis area. 4 open road density classes were used ranging from 0 miles of open road/mi^2 to 2+ miles of open road/mi^2.

Table 2. A comparison of high and low elevation habitats using classes of availability-use (-,=,+), proportion of radio locations (P), and number of radio locations (n) of grizzly bears in the Swan Mountains, Montana, 1987-1992.

Sex/Age	Low Elevation			High Elevation		
	Bear Use	P	n	Bear Use	P	n
Ad Fem	-	.30	285	+	.70	652
Sub Fem	=	.37	123	=	.63	211
Ad Male	=	.39	95	=	.61	151
Sub Male	=	.39	70	=	.61	110

Percent of Area:
Low elevation = 41%
High elevation= 59%

Table 3. Grizzly bear use of silviculturally treated and untreated stands at low and high elevation using classes of availability-use (-,=,+), proportion of radio locations (P), and number of radio locations (n) in the Swan Mountains, Montana, 1987-1992.

	Low Elevation						High Elevation					
	Untreated			Treated			Untreated			Treated		
	Use	P	n	Use	P	n	Use	P	n	Use	P	n
Ad Fem	-	.24	222	-	.07	63	+	.67	628	=	.03	24
Sub Fem	=	.32	105	-	.05	18	=	.62	205	=	.01	4
Ad Male	=	.27	66	=	.12	29	=	.58	143	=	.03	8
Sub Male	=	.28	51	=	.11	19	=	.59	106	=	.02	4

Percent of Area:
Low elevation untreated Stands =28%
Low elevation treated stands =13%
high elevation untreated stands =57%
high elevation treated stands = 3%

Table 4. Grizzly bear use of 3 low elevation habitats using classes of availability-use (-,=,+), proportion of radio locations (P), and number of radio locations (n) in the Swan Mountains, Montana, 1987-1992.

	Silviculturally Treated Stands			Untreated Forested Stands			Untreated Open Habitats		
Age/sex	Use	P	n	Use	P	n	Use	P	n
Ad Fem	-	.22	63	=	.38	108	+	.4	114
Sub Fem	-	.15	18	=	.44	49	+	.46	56
Ad Male	=	.31	29	-	.27	26	+	.42	40
Sub Male	=	.27	19	-	.23	16	+	.5	35

Percent of low elevation area:
Treated stand = 31%
Untreated forested stand = 43%
Untreated Open habitats = 26%

Table 5. Grizzly bear use of roaded and unroaded habitats at low and high elevations using classes of availability-use (-,=,+), proportion of radio locations (P), and number of radio locations (n) in the Swan Mountains, Montana, 1987-1992. (All roads included (open and closed)).

	Low Elevation						High Elevation					
	Unroaded			Roaded			Unroaded			Roaded		
	Use	P	n	Use	P	n	Use	P	n	Use	P	n
Ad Fem	=	.03	27	-	.28	258	+	.44	412	+	.26	240
Sub Fem	=	.03	9	=	.34	114	+	.47	156	=	.17	55
Ad Male	=	.05	13	=	.33	82	=	.41	100	=	.21	51
Sub Male	=	.02	4	=	.37	66	=	.38	68	=	.23	42

Percent of Area:
low unroaded = 3%
low roaded = 38%
high unroaded = 39%
high roaded = 20%

Table 6. Grizzly bear use of 4 classes of total road density using classes of availability-use (-,=,+), proportion of radio locations (P), and number of radio locations (n) in the Swan Mountains, Montana, 1987-1992. (all but revegetated roads included).

	Precise Total Road Density											
	Unroaded			0.1-1 mi/mi^2			1-2 mi/mi^2			> 2 mi/mi^2		
	Use	P	n	Use	P	n	Use	P	n	Use	P	n
Ad Fem	+	.47	439	+	.26	241	=	.16	150	-	.11	107
Sub Fem	+	.49	165	=	.25	83	=	.19	64	-	.07	22
Ad Male	=	.46	113	+	.28	68	=	.14	34	-	.13	31
Sub Male	=	.4	72	+	.28	50	=	.18	32	-	.14	26

Percent of Area:
Unroaded = 42% 0.1-2.0 =17%
0.1-1.0 = 19% >2.0 =22%

Table 7. Grizzly bear use of 4 classes of open road density in using classes of availability-use (-,=,+), proportion of radio locations (P), and number of radio locations (n) in the Swan Mountains, Montana, 1987-1992. (permanently open and seasonally open roads only).

	Precise Open Road Density											
	0 mi/mi^2			0.1-1 mi/mi^2			1-2 mi/mi^2			> 2 mi/mi^2		
	Use	P	n	Use	P	n	Use	P	n	Use	P	n
Ad Fem	+	.69	650	=	.15	137	-	.1	89	-	.07	61
Sub Fem	=	.62	208	+	.21	70	=	.13	42	-	.04	14
Ad Male	=	.66	162	+	.22	54	-	.05	13	-	.07	17
Sub Male	=	.63	113	=	.16	28	=	.14	25	=	.08	14

Percent of Area:
0 = 61% >2.0 =13%
0.1-1.0 = 13%
1.0-2.0 = 13%

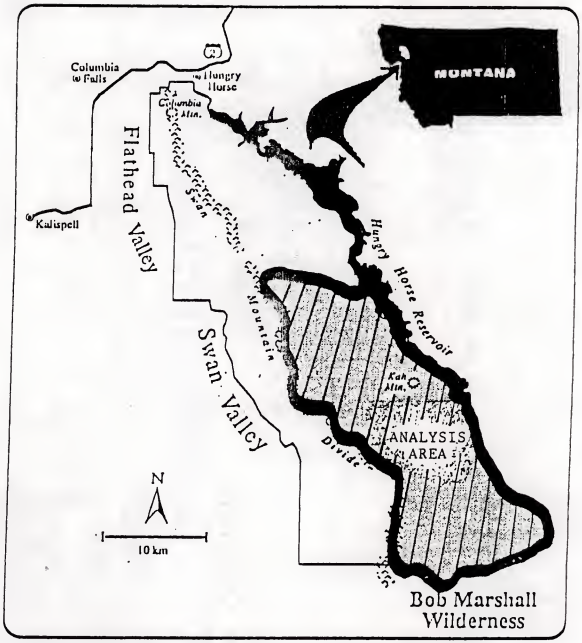
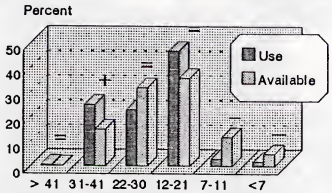


Figure 1. Location of the analysis area in the Swan Mountains of western Montana.

Age of Harvest Stand
and grizzly Bear Use

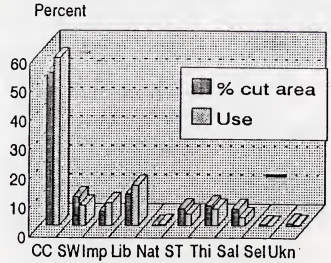


Use	0.6	25	23	47	3	2
Available	0.3	15	32	36	12	5

Age (Since 1992)

Uses only locations in harvested unit (exclude Wheeler Cr. Burn)

Removal Method
Grizzly Use



% cut area	53	10	5	11	0.3	6	7	6	0.4	1
Use	58	7	8	14	0.6	4	6	3	0	0.6

% of locations in harvest stand only, not % total Locations

Figure 2. Grizzly bear use of treated stands. Removal method and age of stand.